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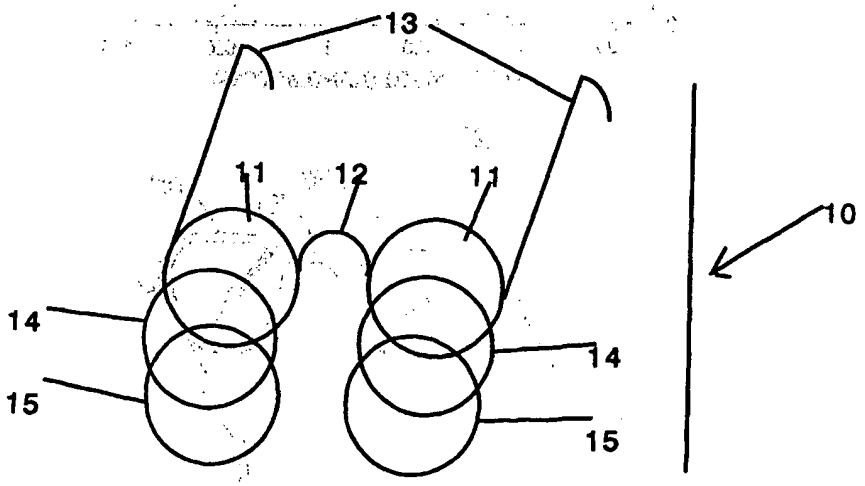
(54) Title: OPTICAL SYSTEM FOR INCREASING CONTRAST OF OBJECT VIEWED THROUGH IT



(57) Abstract: An optical system for increasing the contrast of an object viewed there through which comprises a lenses (11), color filters (14) and polarizers (15).

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OPTICAL SYSTEM FOR INCREASING CONTRAST OF OBJECT VIEWED THROUGH IT

FIELD OF THE INVENTION

The present invention relates to an optical system for increasing the contrast of an object viewed through it, thereby enabling the viewer to selectively locate the object in its surroundings. Especially advantageous is the incorporation of a spotting scope or monocular as part of the optical system in order to provide magnification and create a greater contrast between a golf ball (generally white) and its golf course environment. This contrast helps the user find his or her golf ball more easily.

BACKGROUND OF THE INVENTION

U.S. Patent No. 5,218,386 describes an apparatus for increasing perception of the color of an object. The apparatus comprises one optical filter worn over the left eye and provided with spectral response having three peaks, one each for red, green and blue tuned to the maximum responsiveness of the eye to those colors. Another optical filter worn over the right eye is similar to the first filter, but has peaks tuned to complementary portions of the visual spectrum.

U.S. Patent No. 5,363,152 describes a pair of eyeglasses for enhancing the true color of an object. The eyeglasses have lenses, one of which has a filter to prevent a predetermined portion of reflected light from the object from entering one eye while allowing a second predetermined portion of the reflected true color of an object to enter the other eye, thereby enhancing the true color of the object.

U.S. Patent No. 5,408,278 describes eyeglasses for enhancing visual and color perception. The eyeglasses have specially balanced and integrated lens pairs, one lens allowing transmission of light predominantly from the shorter half of the visible spectrum (400 to 550 nm) and the other lens allowing transmission from the longer half of the visible spectrum (from 550 to 750 nm), that are used to subtract specific quantities of selected visible light from the ambient input to each of the two eyes.

U.S. Patent No. 5,592,245 describes an apparatus for enhancing the perception of a yellow tennis ball that comprises an optical filter through which the viewer views the tennis ball. The filter has a pronounced peak transmittance around 500 to 600 nanometers that passes a high percentage of incident light reflected and fluoresced by the tennis ball, but passes a substantially lower percentage of light in the remaining portion of the visible spectrum.

U.S. Patent No. 5,646,781 describes an optical filter to provide an enhanced image. The filter comprises a substrate including a substantially transparent material, the substrate having a first surface and a multilayer coating on the first surface of the substrate, the multilayer coating including first layers of a first transmissive material having a high index of refraction and second layers of a second transmissive material having a low index of refraction, wherein the first layers have an optical thickness greater than the optical thickness of the second layers, the optical filter blocking passbands substantially centered at 490 nm and 590 nm.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an improved optical system for increasing the contrast of an object viewed through it.

It is an object of the present invention to provide an improved optical system for locating a golf ball against its grassy surroundings.

It is an object of the present invention to provide the improved optical system in a spotting scope, thereby better enabling the viewer to locate the object in its surroundings.

It is an object of the present invention to provide the improved optical system in the convenient form of eyeglasses.

These objects and others that will become apparent from the following specification are achieved by providing an optical system having a selective optical wavelength filtering characteristic for increasing a contrast between a white object (e.g., a golf ball) and a vegetation background. For example, the filter blocks green or green-yellow light wavelengths. In addition, a polarizer is provided for blocking glare and enhancing color contrast.

The polarizer may also be a compound polarization optic, for example a triplet including two crossed polarizers with a mid-crossed polarizer therebetween.

Preferably, the improved optical system for increasing the contrast of an object viewed through it comprises in combination a lens, a polarizer and a green or green-yellow blocking filter, for example a red, magenta or blue pass filter. The filter preferably has a uniform optical retardance in order to avoid birefringent effects from the polarizer.

Preferred is an optical system in which the lens is part of a multi-lens non-inverting optical system, such as a known spotting scope. Such an optical system may also contain a reticle, illuminator, range finder (e.g., laser, optical or triangulation) or other features known in the art.

In another embodiment, the optical system may contain a binocular pair of lenses, each set in an eyeglass frame, each lens having a vegetation suppressing optical filter and a polarizer, or an integral optical filter and polarizer.

The filters may be absorption filters or dichroic filters. One preferred filter type is therefore a green blocking (magenta) dichroic filter. Alternatively, a preferred absorptive

filter is a WRATTEN #32 filter. The filter may also comprise an electrooptic element or tunable filter. Thus, in different seasons, the vegetation may include differing predominant characteristic wavelengths. The optical filters may therefore be changed or adjusted for maximum contrast for the particular conditions. It has been found that, although a magenta (pass) filter is advantageous when the vegetation is lush, when the vegetation is wooded or is subjected to dry conditions, a blue (pass) filter may be preferred. For example, a pass band to stop band ratio of the optical filter may be at least about 4. The filter may be a magenta filter having a pass wavelength band of about 300 to about 500 nm and about 600 to about 750 nm or the filter may be a blue filter having a pass wavelength band of about 400 to about 500 nm, having a relatively high attenuation at visible wavelengths outside the pass wavelength band.

In one embodiment, a so-called "ruby" coated objective lens spotting scope is provided with a dichroic magenta (pass) filter and polarizer in front of the objective. The polarizer is either a circularly polarized or a linearly polarized filter which is freely rotatable to optimize attenuation of reflected glare. The ruby coating is a known method for increasing contrast for terrestrial viewing. However, the known ruby coatings provide insufficient attenuation of the predominant vegetation reflection wavelengths.

In another embodiment, a set of "clip-on" eyeglasses is provided having a vegetation filtering color and polarization.

In a still further embodiment, a pair of eyeglasses is provided having an optical filter tuned to block predominant vegetation reflections, for example from grass, and having an optical polarizer in front (away from the eye) which can be adjusted together for optimum glare reduction.

In contrast to normal sunglass styles, the optical filtering according to the present invention typically provides a wider separation between the optical passband and stop band. Since the typical object to be seen is a bright white (golf ball), the amount of attenuation in the passband is less critical than the difference in attenuation between the passband and stop band. Thus, theatrical or scientific grade filters are preferred, as compared to the more neutral filters typically associated with comfortable human viewing.

Normal sunglasses are intended for extended use by the viewer, while optical systems according to other embodiments of the present invention are intended for short term

intermittent viewing, and therefore of a duration sufficiently short so that the human visual system does not fully accommodate for the effect. These embodiments therefore encompass the spotting scope and temporary eyeglass "clip-on" embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates the optical system of the invention used in conjunction with a pair of eyeglasses.

FIG. 2 illustrates a first embodiment of a spotting scope used in conjunction with the optical system of the invention.

FIG. 3 illustrates a second embodiment of a spotting scope used in conjunction with the optical system of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

There are a number of suppliers of polarizers. For example, a preferred polarizer is available from Tiffen, Inc. Linear polarizers are preferred. Similarly, there are a number of suppliers of filters. The preferred magenta filter is a dichroic filter, such as one supplied by Lee. Other interference or dichroic filters may also be used. Such filters are available from, for example, Lee (filter #113 or filter #046) or Roscolux (filter #46). WRATTEN No. 32 filters are supplied by Kodak, the specification of each of which is expressly incorporated herein by reference. The WRATTEN No. 32 is an absorption type of filter.

FIG. 1 illustrates one embodiment of the optical system 10 of the invention (everything to the left of the vertical line indicated by "10"). Corrective lenses 11 are set in eyeglass frame 12 , which has side frames 13. In front of lenses 11 are magenta filters 14. In front of magenta filters 14 are polarizers 15. The filters 14 and polarizers 15 may be made to clip-on the glasses. For the situation where the intended user does not wear corrective lenses, 11 represent openings in the frame in which filters 14 and polarizers 15 may be mounted, preferably dichroic filters.

FIG. 2 illustrates another embodiment of the optical system 20 of the invention (everything above the horizontal line indicated by "20"). Spotting scope 21 has an objective lens 22 at its left end and an eyepiece lens 23 at its right end. Reticle 24 is located inside spotting scope 21 toward the end with the eyepiece lens 23. In front of objective lens 22 is magenta filter 25, and in front of magenta filter 25 is polarizer 26. The viewer's eye is indicated at 27.

EXAMPLE 1

These are some of the filter/polarizer combinations that were tested and the results obtained from those tests. WRATTEN filters and Orion filters used are absorption filters, and the Lee and Roscolux filters used are interference or dichroic filters. The polarizer used was a Tiffen polarizer.

Filters/Polarizer Used	Observation
I. Magenta WRATTEN #32 filter OR: II. Magenta dichroic (Lee filter #113 or Lee filter #046 or Roscolux filter #46)	- makes green and brown appear slightly darker and the white ball appear a little violet. Provides modest contrast.
III. Magenta WRATTEN #32 with a polarizer OR: IV. Magenta dichroic (Lee filter #113 or Lee filter #046 or Roscolux filter #46) with a polarizer	-makes green and brown appear very dark while allowing the white ball to stand out. Excellent contrast and a preferred lens pair.
V. Red Orion #25 with polarizer OR: VI. Red dichroic filter (Lee filter #26 or Rosco #6500) with polarizer	-makes green and brown appear darker, but also makes the white ball appear slightly darker and reddish. Provides an increase in contrast, but not as well as the magenta filters.
VII. Violet Orion #47 with polarizer	-makes all colors appear dark and a low degree of separation of the white ball much from its environment.
VIII. Orange Orion #21 with polarizer OR: IX. Orange Lee filter #105 with polarizer	-makes the green grass appear relatively light and provides modest contrast against the golf ball.
X. Blue Orion #38A with polarizer OR: XI. Blue dichroic Lee Filter #119 with polarizer	- makes all colors appear darker and doesn't make the white ball stand out much against green vegetation. The white ball has a bluish tint. However, the blue filter works very well in increasing contrast of a golf ball against yellowish grass or wooded or brown vegetation.

Yellow and green filters were also tried separately with the polarizer, but these filters provide diminished contrast for the ball against a green and brown background, as compared to the preferred magenta filter.

EXAMPLE 2

A further embodiment of the optical system 20' provides a series of three HN42 Polaroid brand polarizer filters 25', 25", 25'", placed in series. The two outer polarizers 25', 25'" are inclined at about 90 degrees with respect to each other, while the middle polarizer 25" is inclined at about 45 degrees with respect to the other two, therefore having a polarization axis mid-way between the two outer polarizers 25', 25'". The polarizers 25', 25", 25'" are provided behind an objective lens 22, with the outer polarizers 25', 25'" respectively inclined along horizontal and vertical axes, as defined by a reticle 30. The color filter 24 is preferably a Schott brand BG25 filter located in front of the eyepiece lens 23. The optical system with optical filters 24, 25', 25", 25'" is advantageously a spotting scope, having a magnification of preferably between 5-7X, with a 50mm objective lens 22, and with the color filter 24 located between the eyepiece lens 23 and the polarizers 25', 25", 25'". The viewer's eye is indicated at 27.

The foregoing specification and drawings have thus described and illustrated a novel optical system for increasing contrast of an object viewed through it that fulfills all of the objects and advantages sought therefore. Many changes, modifications, variations and other uses and applications of the subject invention will, however, become apparent to those skilled in the art after considering this specification which discloses the preferred embodiments thereof. All such changes, modifications, variations and other uses and applications which do not depart from the spirit and scope of the invention are deemed to be covered by the invention, which is to be limited only by the claims which follow.

What is claimed is:

1. An optical system for increasing the contrast of an object viewed through it which comprises a visible vegetation filter selectively passing light having a specific polarization angle.

2. An optical system as claimed in claim 1, in which the improved optical system for increasing the contrast of an object viewed through it comprises in combination a lens, a polarizer and a green or green-yellow blocking filter.

3. An optical system as claimed in claim 1, in which the lens is part of a multilens non-inverting optical system.

4. An optical system as claimed in claim 3, in which the optical system also contains a reticle.

5. An optical system as claimed in claim 3, in which the lens system is a spotting scope.

6. An optical system as claimed in claim 1, in which the filter is an absorption filter.

7. An optical system as claimed in claim 6, in which the filter is a WRATTEN No. 32 filter.

8. An optical system as claimed in claim 1, in which the filter is a dichroic filter.

9. An optical system as claimed in claim 8, in which the filter is a Lee #113 or #046 filter or Roscolux #46 filter.

10. An optical system as claimed in claim 1, in which the optical system comprises two corrective lenses, each set in eyeglass frames, each lens having a magenta filter and a polarizer in front of it.

11. An optical system as claimed in claim 1, in which a pair of lenses are mounted in eyeglass frames and each optical system also comprises a magenta filter and a polarizer.

12. An optical system as claimed in claim 1, in which the filter is a magenta or blue pass filter.

13. An optical system as claimed in claim 12, in which the filter is a magenta filter having pass wavelength bands of about 300 to about 500 nm and about 600 to about 750 nm or the filter is a blue filter having a pass wavelength band of about 400 to about 500 nm, having a relatively low attenuation in the pass wavelength band and having a relatively high attenuation at visible wavelengths outside the pass wavelength band.

14. An optical system according to claim 13, wherein a pass band to stop band attenuation ratio is at least about 4.

15. A telescopic optical system comprising in combination a telescope, a filter and a polarizer and having a pass characteristic sufficient to increase the contrast between a golf ball and a vegetative background.

16. A method for increasing the contrast of a reflective object against a vegetation background, comprising viewing the object through an optical system having a lens, a magenta filter and a polarizer in series.

17. A method as claimed in claim 16, in which the lens is part of a multilens non-inverting lens system.

18. A method as claimed in claim 17, in which the lens system is a spotting scope.

19. A method as claimed in claim 17, in which the optical system also contains a rangefinder for determining a range to form the optical system to the object.

20. A method as claimed in claim 16, in which the filter is a dichroic filter.

21. A method as claimed in claim 16, in which the magenta filter is a WRATTEN No. 32 filter.

22. A method as claimed in claim 16, wherein the optical system comprises two lenses, each set in eyeglass frames, each lens having a magenta filter and a polarizer in front of it.

23. A method as claimed in claim 16, wherein the optical system has an optical wavelength having a pass characteristic sufficient to increase the contrast between a golf ball and vegetative background.

24. A method for increasing the contrast of a reflective object against a vegetation background, comprising viewing the object through an optical system having a blue color filter and a set of crossed polarizers having an intermediate mid-crossed polarizer, in series.

25. The method according to claim 24, wherein the crossed polarizers have an inclination angle of about 90 degrees and the mid-crossed polarizer has an inclination of about 45 degrees.

26. The method according to claim 25, further comprising a reticle having an upright indication, wherein the crossed polarizers are inclined horizontally and vertically with respect to the upright indication of the reticle.

27. An optical system for increasing the contrast of a reflective object against a vegetation background, comprising a blue color filter and a set of crossed polarizers having an intermediate mid-crossed polarizer, in series.

28. The system according to claim 27, wherein the crossed polarizers have an inclination angle of about 90 degrees and the mid-crossed polarizer has an inclination of about 45 degrees.

29. The system according to claim 27, further comprising a reticle having an upright indication, wherein the crossed polarizers are inclined horizontally and vertically with respect to the upright indication of the reticle.

30. The system according to claim 27, further comprising a spotting scope, wherein the color filter and polarizers are located between an objective and an eyepiece.

31. The system according to claim 27, wherein said polarizers are Polaroid brand HN42.

32. The system according to claim 27, wherein the blue filter is a Schott brand BG25 filter.

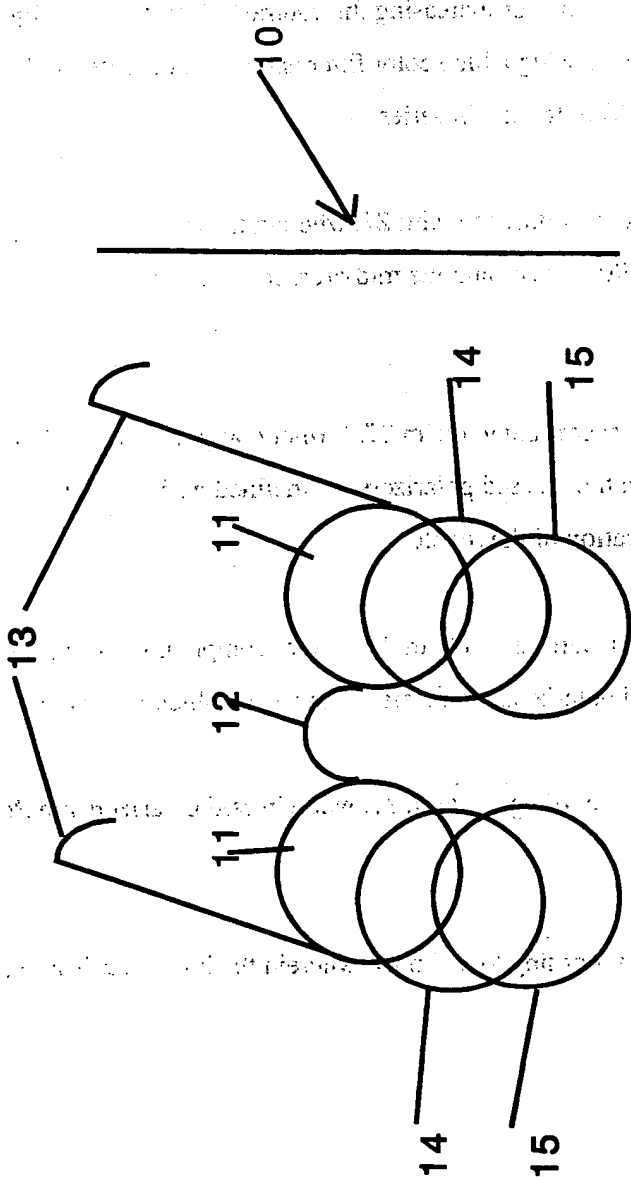

FIG. 1

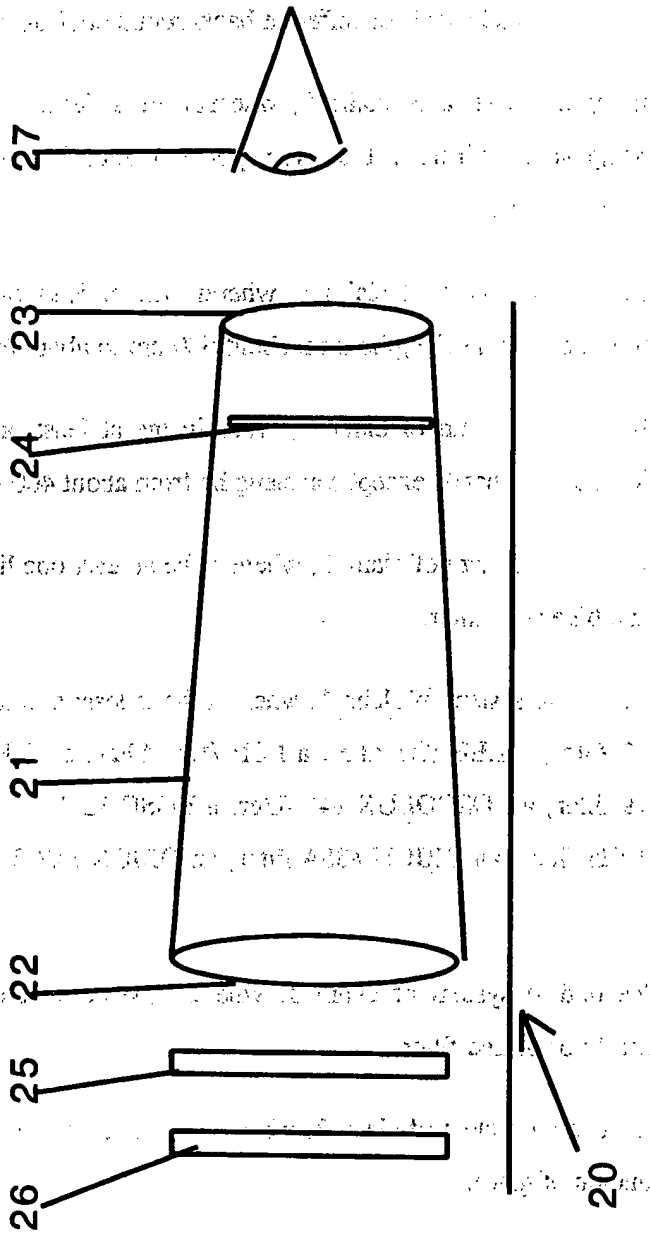

FIG. 2

8. The optical system of claim 1, wherein the optical system is characterized in that the at least one light filter is adjusted for different background environments.

9. The optical system of claim 8, wherein the at least one light filter is a magenta filter when the background environment is lush vegetation and a blue filter when the background environment is dry or wooded.

10. The optical system of claim 1, wherein the at least one light filter substantially attenuates a spectral band of wavelengths from about 500 nm to about 600 nm.

11. The optical system of claim 1, wherein the at least one light filter substantially attenuates all visible spectral bands except wavelengths from about 400 nm to about 500 nm.

12. The optical system of claim 1, wherein the at least one light filter comprises one of a red, magenta, and blue pass filter.

13. The optical system of claim 1, wherein the at least one light filter comprises one of a WRATTEN #32 filter, a LEE #26 filter, a LEE #046 filter, a LEE #105 filter, a LEE #113 filter, a LEE #119 filter, a ROSCOLUX #46 filter, a ROSCOLUX #6500 filter, an ORION #21 filter, an ORION #25 filter, an ORION #38A filter, an ORION #47 filter, and a SCHOTT BG26 filter.

14. The optical system of claim 3, wherein the at least one polarizer is one of a circularly and linearly polarized filter.

15. The optical system of claim 3, wherein the at least one polarizer is freely rotatable to optimize attenuation of glare.

16. The optical system of claim 3, wherein the at least one polarizer is one of a POLAROID HN42 polarizer and a TIFFEN polarizer.

17. The optical system of claim 3, wherein the at least one polarizer comprises:

a first polarizer having a first polarization axis;

a second polarizer positioned next to said first polarizer, said second polarizer having a second polarization axis; and

a third polarizer positioned next to said second polarizer, said third polarizer having a third polarization axis, said third polarization axis being inclined at about 90° to the first polarization axis;

wherein said second polarization axis is inclined at about 45° to the first and third polarization axes.

18. An optical system providing contrast between a golf ball and its background environment, comprising:

at least one light filter for substantially attenuating at least one spectral band emitted from the background environment;

at least one polarizer for attenuating glare and enhancing color contrast; and

means for holding said at least one light filter and said at least one polarizer in an arrangement suitable for viewing therethrough by at least one eye of a viewer.

19. The optical system of any of claims 1-18, wherein the holding means comprises one of an eyeglass frame and a removable attachment to an eyeglass frame.

20. The optical system of any of claims 1-18, wherein the holding means comprises a spotting scope, said optical system further comprising:

an eyepiece lens positioned at a viewing end of the spotting scope;

a reticle positioned between said eyepiece lens and the at least one light filter; and

an objective lens positioned between said reticle and the at least one light filter.

21. The optical system of any of claims 1-20, wherein said optical system further comprises at least one of a reticle, a rangefinder, an illuminator, a roof prism, and a magnifier.

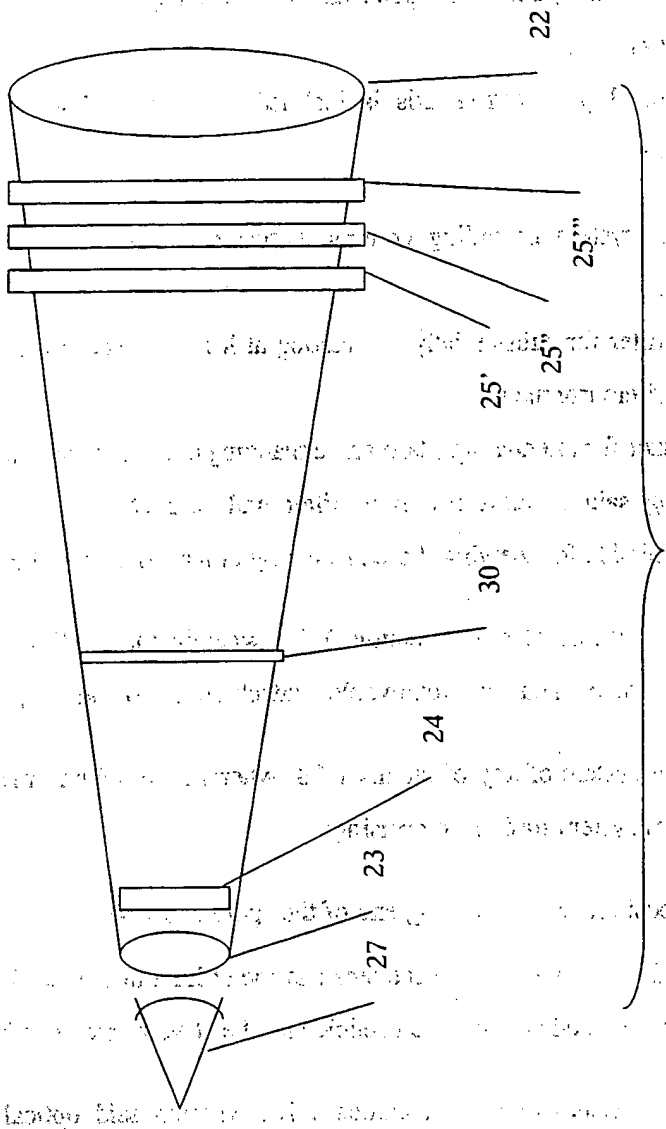

FIG. 3

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :G02B 5/22, 27/28; G02C 9/00, 7/12, 7/00, 7/10;
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B. FIELDS SEARCHED

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U.S. : 351/47, 49, 53, 163; 359/502, 885, 889, 890, 892;

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,200,852 (GEHMANN) 06 April 1993 (06.04.1993), see entire document.	1-9, 16-21 and 23-32
X	US 2,986,969 (MUNCHERYAN) 06 June 1961 (06.06.1961), see figures 1-4.	10-16 and 22

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"P"	document published prior to the international filing date but later than the priority date claimed		

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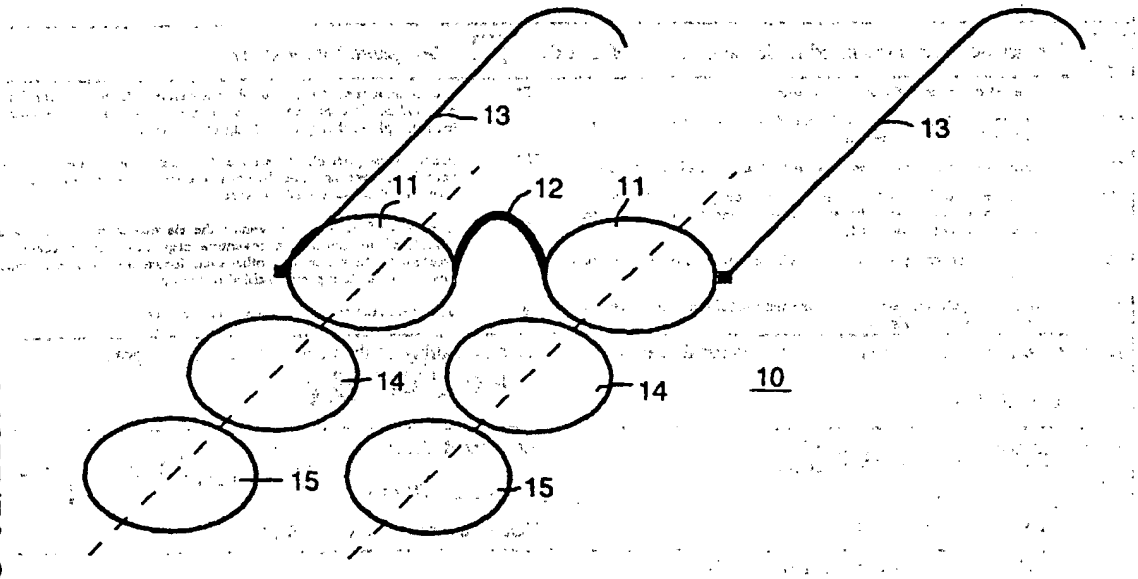

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AMENDED CLAIMS

[received by the International Bureau on 23 March 2001 (23.03.01); original claims 1-21 amended; original claims 22-32 cancelled (3 pages)]

1. An optical system providing contrast between a golf ball and its background environment, comprising:

at least one light filter for substantially attenuating at least one spectral band emitted from the background environment;

at least one means for attenuating glare and enhancing color contrast; and

means for holding said at least one light filter and said at least one means for attenuating glare and enhancing color contrast in an arrangement suitable for viewing therethrough by at least one eye of a viewer.

2. The optical system of claim 1, wherein the optical system is part of a multilens non-inverting optical system.

3. The optical system of claim 1, wherein the at least one means for attenuating glare and enhancing color contrast comprises at least one polarizer.

4. The optical system of claim 1, wherein the at least one light filter substantially attenuates a spectral band comprising at least one of green and green-yellow light.

5. The optical system of claim 1, wherein the at least one light filter is characterized in that its pass band to stop band transmittance ratio is at least 4 to 1.

6. The optical system of claim 1, wherein the at least one light filter comprises one of an electrooptic element and a tunable filter.

7. The optical system of claim 1, wherein the at least one light filter comprises one of an absorption filter and a dichroic filter.